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ABSTRACT

The Science and Mathematics Education Centre (SMEC) was established in 1979 in the Division of Engineering and Science at Western Australian Institute of Technology. The establishment of an autonomous SMEC, physically located in a science/mathematics environment, is helping to bridge the gap between secondary science/mathematics teachers and specialists by: involving higher education specialists in secondary school-based research and development (R&D) activities; sponsoring activities such as discipline-oriented workshops and seminars for science/mathematics teachers and students; sponsoring visits by science/mathematics education specialists from within Australia and overseas; and by providing avenues for higher education discipline experts to become involved in school activities such as field trips and extension activities for intellectually gifted students. In addition to graduate courses (leading to Master of Applied Science Degree and Graduate Diploma in Science Education) and such R&D activities as applied educational research, curriculum development, and evaluation studies, the center is directly involved in several on-going outreach activities. In addition to workshops and seminars, these activities include producing a newsletter and information broadsheets, sponsoring of visiting fellowships, and fostering industry/education relationships. The approach to continuing science/mathematics teacher professional development evolved at SMEC could be readily adopted by other institutions of higher education. (JN)

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SCIENCE & MATHEMATICS EDUCATION CENTRE

TECHNICAL REPORT SERIES

Technical Report 8

An approach to the continuing professional development of science and mathematics educators.

J Dekkers, M J O'Loughlin, D F Treagust

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AN APPROACH TO THE CONTINUING PROFESSIONAL DEVELOPMENT OF SCIENCE AND MATHEMATICS EDUCATORS

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February, 1983

SCIENCE AND MATHEMATICS EDUCATION CENTRE

WESTERN AUSTRALIAN INSTITUTE OF TECHNOLOGY

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TECHNICAL REPORT SERIES

The Technical Report Series of the Science and Mathematics Education Centre (SMEC) was initiated in 1980. The series provides a mechanism for communicating results of research and developmental projects to others in science and mathematics education. The reports include details and information not often included in published papers.

The Science and Mathematics Education Centre was established in 1978 as a separate unit within the Division of Engineering and Science. The functions of the SMEC are to serve science and mathematics educators within the community and within WAIT by acting as:

- a centre for graduate studies in science and mathematics education;
- a focal point for research and development activities in science and mathematics education;
- an information and dissemination centre for science and mathematics education literature and resources;
- a focal point for contact between science and mathematics educators, professional organisations, industry personnel and the general community.

The SMEC offers two graduate courses, the Graduate Diploma in Science Education and the Master of Applied Science (Science Education). Both courses are primarily intended to enhance science and mathematics educators' professional development. This is achieved in the Graduate Diploma through the provision of courses of study that include science and/or mathematics and science and mathematics education. The Master of Applied Science (Science Education) is examined entirely by thesis. Research projects and theses undertaken by graduate students emphasize the applications of science education, mathematics education and computer education relevant to their professions.

Information concerning the Technical Report Series can be obtained from the Head of the Science and Mathematics Education Centre.

Dr John Dekkers
Head
SCIENCE AND MATHEMATICS EDUCATION CENTRE

INTRODUCTION

A recent survey of university and school science educators in the United States identified a number of problems facing science education in that country (Gallagher and Yager, 1981). These problems included a lack of vision and leadership in schools and universities, a lack of teacher motivation and continuing professional growth, limited scholarly dialogue between researchers and practioners and inappropriate avenues for continuing education of science teachers. Power's (1979) ten year review of developments in science education research in Australia would tend to imply that similar problems to those in the United States apply to the science education community in Australia.

Gallagher and Yager (1981) suggest a number of areas where action is needed to overcome the problems facing science education. One area of action is the provision of continuing education programmes for practicing science teachers which have a close relationship with the schools and which encourage dialogue between researchers and practioners. Indeed, it is conceded by many educators that continuing education for practicing science and mathematics teachers is a necessity (De Rose, Lockard and Paldy, 1980; Gallagher, 1982; Gehrke, 1979).

Continuing professional development programs for science and mathematics teachers can include workshops, short courses, seminars and conferences organised by either teacher employing authorities, professional associations or tertiary institutions. In this way

teachers can be introduced to new developments and ideas for refresher purposes (Betjeman, Dymond and Schock, 1979; Betjeman, 1981). However for science and mathematics teachers seeking to develop more substantial skills and knowledge relating to subject content, instructional processes in teaching, curriculum development, evaluation, etc., it seems necessary to undertake a sustained course of study such as a post graduate degree at a tertiary institution. The range of continuing professional development activities alluded to above is rarely the focus of a single organisation. This paper describes a centre which conducts graduate courses, and holds workshops, seminars, short courses and conferences, for the continuing professional development of science and mathematics teachers. The authors contend that the overall approach to professional development at the Centre, which is described here, has contributed to promoting dialogue between practitioners, educational researchers, discipline experts and the wider community in Western Australia.

THE SCIENCE AND MATHEMATICS EDUCATION CENTRE (SMEC)

The SMEC was established in 1979 in the Division of Engineering and Science at the Western Australian Institute of Technology (WAIT). This tertiary institution has an enrolment of over 12,000 students and is located in Perth, a city with a population of approximately three quarters of a million people. The Centre offers post graduate courses in science and mathematics education, is actively involved in science and mathematics education research and development and in

outreach activities for science and mathematics educators within the Institute and elsewhere.

RATIONALE AND CHARACTER OF THE SMEC

In Western Australia, and typically elsewhere in Australia, a gap has traditionally existed between secondary science/mathematics teachers and the specialists in science and mathematics disciplines at tertiary institutions (Power, 1979). Part of the reason for this gap is that once in the teaching workforce, a science or mathematics teacher has little opportunity to interact with tertiary science or mathematics specialists and identifies more with education than with the science or mathematics disciplines. The establishment of an autonomous SMEC physically located in a science/mathematics environment is helping to bridge the gap between secondary science/mathematics teachers and specialists by: a) involving tertiary discipline specialists in secondary school based research and development activities, b) sponsoring activities such as discipline oriented workshops and seminars for science/mathematics teachers and students, c) sponsoring visits by science/mathematics education specialists from within Australia and overseas, d) providing avenues for tertiary discipline experts to become involved in school activities such as field trips and extension activities for intellectually gifted students.

GRADUATE TEACHING

The graduate courses -- a Master of Applied Science Degree and a Graduate Diploma in Science Education -- are regarded as the focus of

the Centre's activities. Both courses are designed to enable students to develop expertise in the field of science/mathematics education and provide students with an opportunity to extend their knowledge in science or mathematics and in education. Both courses are intended for experienced teachers who possess an undergraduate degree in science and/or mathematics together with teaching qualifications and several years teaching experience. The courses are described in greater detail elsewhere (Boud & de Laeter, 1978). The current enrolment is in excess of one hundred students and includes persons from private and state high schools, colleges of advanced education, technical colleges, the State Education Department and nurse education institutions. Almost all SMEC's graduate students are practicing teachers and, therefore, coursework units are offered in the evenings. As well, since teachers in Western Australis and within Australia are often situated in regions remote from tertiary institutions, both the Graduate Diploma and the Master's Degree are offered by the external study mode (distance education). While instruction for external students is performed by SMEC staff, the external programme is administered by the External Studies Department which provides support services for this group of students. External students represent approximately 30% of the enrolments and are located in Western Australia outside the metropolitan area of Perth as well as other States of Australia and Papua New Guinea.

Discipline specialists from within the Division of Engineering and Science are directly involved in the SMEC programme by teaching the

science and mathematics electives. Similarly, those science or mathematics specialists with a background and interest in education teach units in biology education, chemistry education, physics education, mathematics education and computer education. Many of those same staff assist in the supervision of research and development activities and help conduct workshops and seminars.

The instructional strategy in both courses and particularly in the introductory units of the Graduate Diploma involves instructor and students in collaborative planning, teaching and evaluation and is consistent with recommendations of social theorists such as Glasser (1965) and Rogers (1969). By incorporating this learning philosophy in the units, it is possible to both acknowledge and utilize the considerable expertise which students bring to the course. These authors believe that the traditional highly structured, content-oriented, teacher-centred approach often used in graduate programmes in Australia is incompatible with the needs and learning styles of professional educators; further, we believe that such a traditional approach and is equally incompatible with the concept of professional development and renewal. In brief, the basic underlying assumptions of this learning philosophy are that graduate students should become self-directed and self-motivated (Knowles, 1975). This is facilitated by a procedure where, in collaboration with their instructor, students determine the instructional goals and objectives for the unit and later jointly plan and implement group based learning activites. Students also are directly involved in judging the extent to which their goals have been met and are encouraged to

draw upon the resources they need both within and outside educational institutions (Lunetta, Dekkers, O'Loughlin, Treagust, 1981). The introductory external science education units also use a collaborative coursework design; feedback from external students indicates that this aspect of the learning process is well received.

RESEARCH AND DEVELOPMENT ACTIVITIES

While there is considerable evidence that the findings of research in teaching and learning in science and mathematics have had little impact on everyday classroom practice (Gallagher, 1982; Power, 1979), there is a growing awareness among educational researchers that at least a dialogue has started between educational researchers and practioners (Verma and Beard, 1981). However, by involving graduate students who are practicing science and mathematics teachers in the SMEC's research and development activities and by designing these activities to meet the specific needs of the teaching profession in Western Australia it is our intention that the above gap will be further reduced. For example, the marine physics curriculum project (Dekkers, Penrose, Thorley and Young, 1980) arose out of an expressed need for optional units within the existing upper secondary school physics syllabus in Western Australia; research into the use of concept mapping as a tool for student evaluation at the SMEC currently involves a group of chemistry teachers who are seeking alternative ways of identifying student learning difficulties (Cronin, Dekkers and Dunn, 1982); a research study on the state of the art of astronomy teaching in Western Australian schools (O'Loughlin, 1980) identified a number of specific needs for

astronomy instruction in secondary schools -- subsequently the SMEC developed and produced an astronomy resources book for teachers.

Specific examples of staff and graduate investigations at the SMEC currently in progress are as follows:

Applied education research: creativity in the science classroom: educational use of simulation; library science skills; mathematical aids for primary schools; misconceptions in learning secondary science; problem solving in physics; the Rasch technique of measurement in mathematical problem solving; cognitive styles and cognitive preference of student nurses; models for school-industry liaison; secondary students knowledge of and attitudes about energy.

Curriculum developments: marine physics for upper secondary schools; science learning resources for student nurses; astronomy resource packages for teachers; solar energy for secondary science students; a forestry curriculum for technical colleges; a computer education curriculum for lower secondary students.

Evaluation studies: evaluation of distance education studies in tertiary science and mathematics; self evaluation of teacher effectiveness; evaluation of school science assessment strategies; whole-school evaluation; evaluation of individualized learning programmes in secondary science.

OUTREACH ACTIVITIES

A further role of the SMEC is to enhance the links between the Division of Engineering and Science, science/mathematics teachers and students and the community. This is facilitated by several on-going outreach activities which include:

Science and Mathematics Workshops for Secondary Teachers: The programme of workshops for secondary and tertiary science and mathematics teachers is organized by the SMEC and is presented by staff from the Division of Engineering and Science. These workshops are primarily intended to provide teachers with an opportunity to improve their knowledge of recent developments and advances in the subject disciplines as well as to provide ideas for using this knowledge in teaching sciences and/or mathematics at the secondary and tertiary level. The workshop programme has received strong support by way of large attendances. Feedback from workshop attendees has indicated an appreciation for the practical liaison generated between the Division and the classroom teacher. Some recent workshops have been "Activity-oriented Teaching in Mathematics", "Chemistry and Energy", "Marine Physics", "Solar Energy", "The geology and biogeography of the Swan Coastal Plain", "Genetics and Genetic Engineering", "Corrosion Chemistry", "Introducing Computer Education into the School".

Science and Mathematics Education Seminars: The seminar series is a major avenue for graduate students and other educators in secondary and tertiary institutions to keep abreast with some recent

developments in science/mathematics education. Speakers are drawn from local, interstate and overseas tertiary institutions, secondary schools, education authorities and industry.

Science and Mathematics Education Newsletter (SAMEN): A 25-30 page newsletter, produced four times per year by graduate students, is editored by SMEC staff and is circulated to the student body and interested persons (circulation 200). The published materials specifically relate to the interests of science and mathematics teachers and educators and serve as a vehicle for graduate students to acquire the skills necessary for preparing manuscripts for publication and as a means of sharing ideas generated in the graduate programme.

SCI-LINK: Information broadsheets compiled by the SMEC staff highlight activities and events within the Division of Engineering and Science that may be of interest to science and mathematics teachers. SCI-Link is sent three times per year to all secondary schools in Western Australia.

Visiting Fellowships: Since its inception in 1979 the SMEC has yearly sponsored a visiting fellow in science or mathematics education for a period of up to three months. These visits are beneficial in the Centre's efforts to develop links between science educators in Australia and science educators in other countries.

Industry-Education Links: In recent years there has been evidence of growing links between education, industry and business and the community in Western Australia; in part this is due to the trend in the Australian secondary school curriculum towards the more applied or socially relevant aspects of the curriculum especially in the areas of science and technology. In addition career and vocational programmes have developed rapidly in recent years with many of these having a substantial component of work experience or work observation. SMEC staff and students have been involved in many of these industry-education activities including curriculum development, evaluation and teacher inservice.

CONCLUDING REMARKS

The approach to continuing science and mathematics teacher professional development that has evolved at the SMEC could be readily adopted by other tertiary institutions. Furthermore, we believe that the key to the continued impact of the SMEC on the science and mathematics teaching fraternity is the fact that the majority of SMEC's activities are focussed towards teacher professional development and towards research and development in science and mathematics education that is relevant to the needs of the practicing teacher in Western Australian schools and other institutions.

Teacher participation in the SMEC's activities has made it a successful agent for continuing education. This is enhanced by the presence of regular visiting specialists from within Australia and

overseas who are seen as essential in broadening the outlooks and perspectives of both the staff and graduate body towards science and mathematics education. Visiting specialists also provide opportune occasions to bring together the immediate community of science and mathematics educators through workshops/seminars presented by the specialist.

Finally, the location of the SMEC within the Division of Engineering and Science provides not only the obvious contacts between discipline specialists and graduate students who are practicing teachers, but also provides the opportunity to develop a graduate studies program relevant to the needs and interests of practicing science and mathematics teachers. There is considerable evidence to suggest that since the establishment of the SMEC that its activities have achieved much to promote dialogue between secondary science/mathematics teachers and discipline specialists in science/mathematics.

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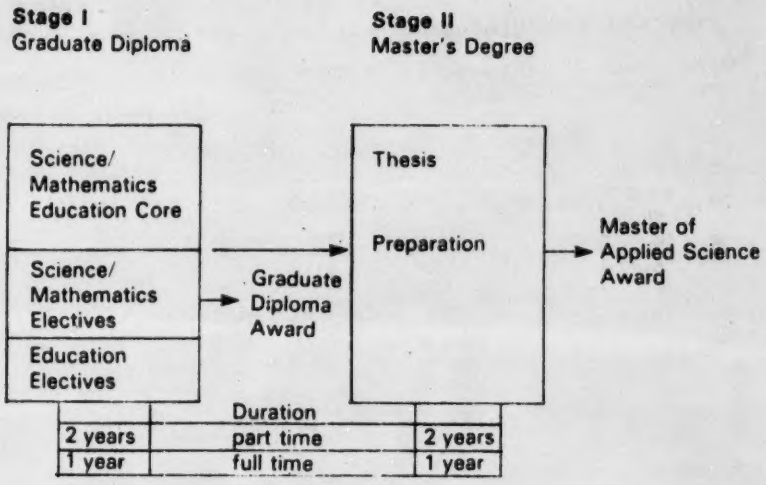

Figure 1

The structure of the Master of Applied Science (Science Education) and Graduate Diploma in Science Education offered by WAIT.

SCIENCE AND MATHEMATICS EDUCATION CENTRE

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